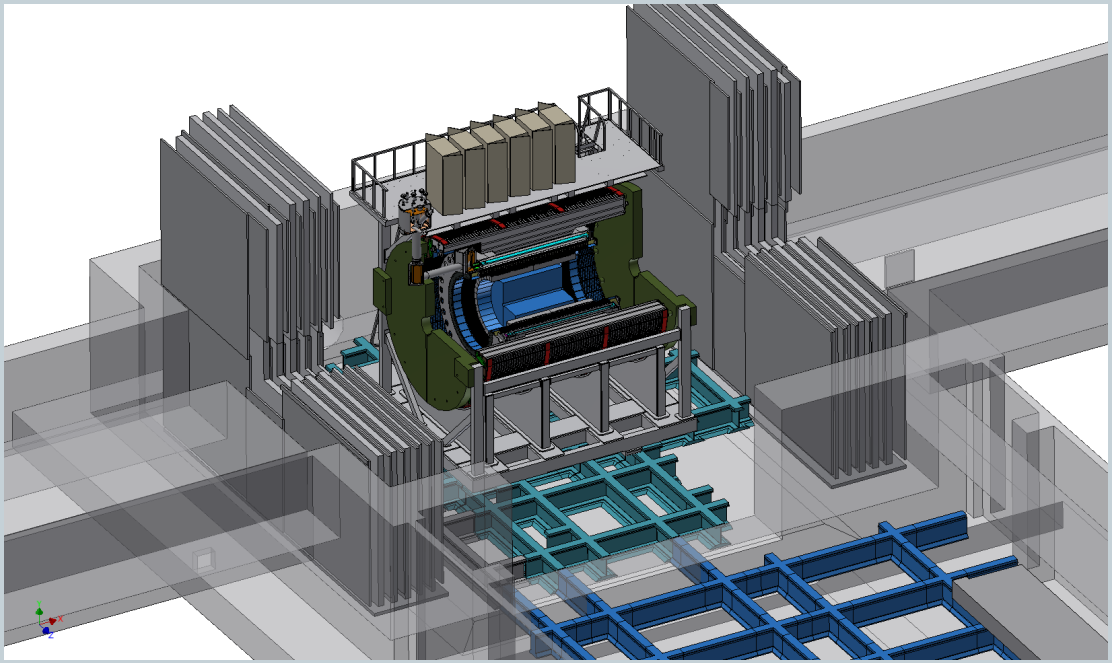
sPHENIX Installation Plan
EMCal Review



Don Lynch

August 20, 2015

sPHENIX Installation: 1008 Considerations

- Floor Loading Limits : 4000 psi, Max
- Crane Lifting Capacity :
  - Assembly Hall (AH): 40 ton main, 5 ton auxilliary
  - Interaction Region (IR): 12 ton main, (2) 1 ton auxilliary
- Opening in Shield Wall (see envelope control drawing)
- Crane Hook Limits (see envelope control drawing)
- Rails
  - Locations (see sPHENIX model Assembly)
  - load limits: Total load at center of beam: TBD (beam Calculation)
- Assembly Hall (AH) space limitations (available space for construction)

Detector Access for Maintenance

- **In general** No access to detectors inside the magnet during a run. Access to all detector rack electronics during a run during maintenance periods from Central Pedestal (CP) platforms. Access to Magnet cooling, monitoring and control services on magnet stack from CP upper platform during maintenance access periods.
- **Outer HCal:** Access Limited access to outer HCal on-detector Electronics during a run maintenance period is possible from CP platforms. No disassembly of Outer HCal sectors anticipated for maintainance
- **Inner HCal:** Limited on-detector electronics front ends maintenance when end plug doors are open. Access to SiPM's and scintillating tiles requires beampipe removal, relocation to AH, removal of full Inner HCal in AH, and would need to be preceded by removal of full Tracker and all EMCal sectors
- **EMCal:** Limited on-detector electronics front ends maintenance when end plug doors are open. Access to SiPM's requires removal of full Tracker, after which individual sectors might be accessible with scaffolding without removal; sectors are designed to be individually removeable in the IR
- **Tracker:** Half or all of Tracker will be removable during shutdown period in IR after end plug doors are opened. EMCal, Inner HCal and Outer HCal do not need to be disturbed for Tracker maintenance
- **Magnet:** Internal portions of Magnet are not serviceable without complete disassembly of sPHENIX. External controls, monitoring and services are serviceable during run maintenance periods and between run maintenance shutdowns without disturbing any detectors.

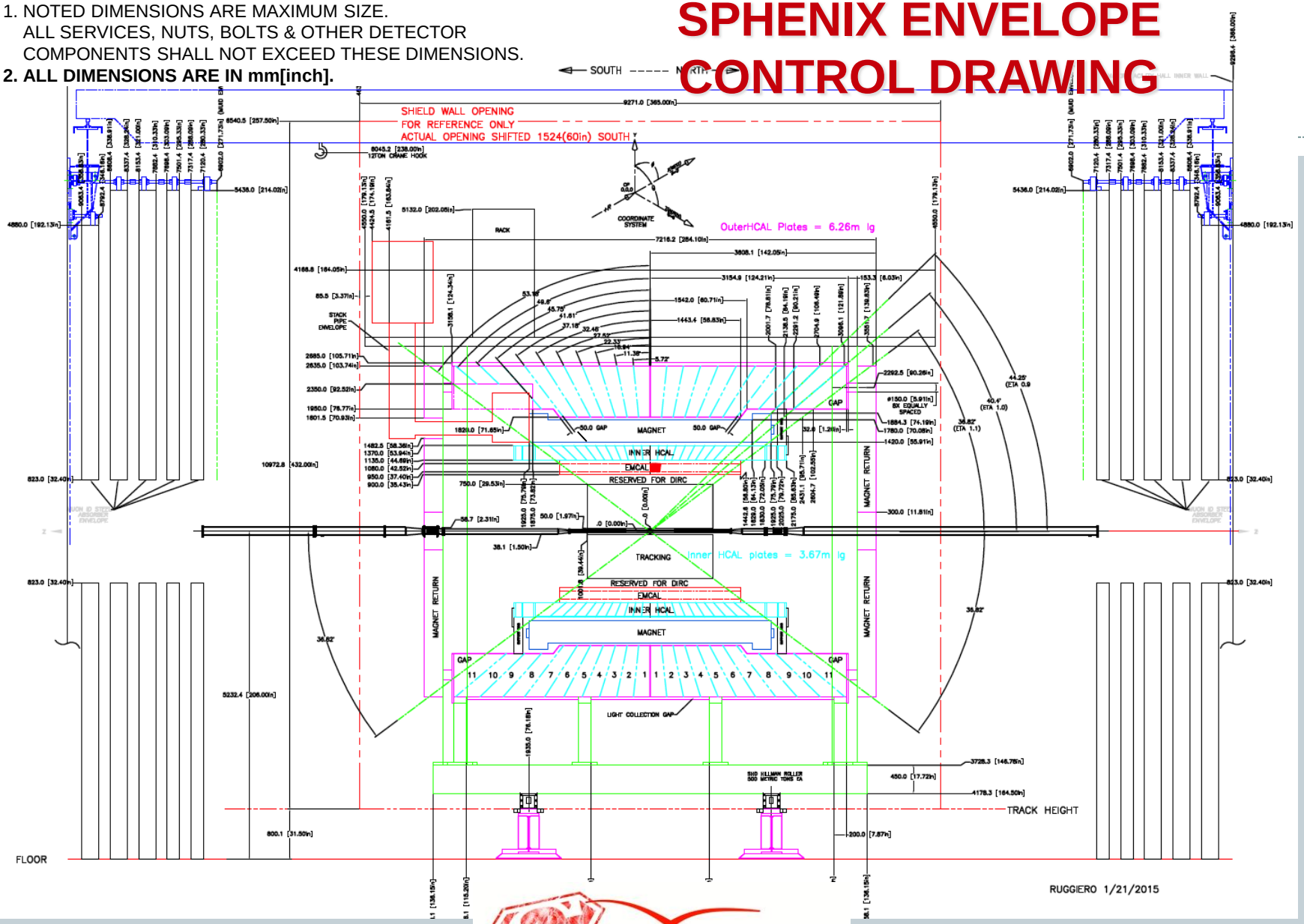
sPHENIX Installation: Prerequisites

- PHENIX Decommissioning:
  - all PHENIX Subsystems & Components removed from 1008 and
- sPHENIX Infrastructure & Installation Tooling:
  - Components procured, QC tested, ready for installation (includes Line electric, cable management, racks, access, safety systems, subsystem structural support members, flux return end caps and main carriage base
- Subsystem Module Assembly & Testing:
  - **32 HCal Outer modules** – assembled, light detection, light collection, cooling and electronics installed, light tight, internally aligned, external fiducials defined, performance tested (~13.5 tons each)
  - **32 HCal Inner modules** - assembled, light detection, light collection, cooling and electronics installed, light tight, internally aligned, external fiducials defined, performance tested (~1 tons each)
  - **32 x 2 EMCal modules** - assembled, light detection, light collection, cooling and electronics installed, light tight, internally aligned, external fiducials defined, performance tested (~1/2 tons each)
  - **2 Tracker half subsystems** – assembled, active components, cooling and electronics installed, internally aligned, external fiducials defined, performance tested (~1/4 ton each)
- sPHENIX Magnet:
  - Low power tested, magnet field alignment defined and mapped onto external fiducials, stack modified to accommodate HCal Outer, full field test using alternate flux return completed, cryo supply components and structural support designed and fabricated, electrical power supply, magnet safety systems designed and tested, monitoring and safety support designed fabricated/procured tested and ready for installation

SPHENIX ENVELOPE CONTROL DRAWING

NOTES:

1. NOTED DIMENSIONS ARE MAXIMUM SIZE.
   ALL SERVICES, NUTS, BOLTS & OTHER DETECTOR
   COMPONENTS SHALL NOT EXCEED THESE DIMENSIONS.
2. **ALL DIMENSIONS ARE IN mm[inch].**



WEIGHT Estimates

Inner Hcal	64,000 lb, 32 ton (Calc) (2000 lb/ module)
Outer HCal	854,000 lb, 427 ton (Calc) (27,000 lb /module)
EMCal (with mounting)	61,000 lb, 31 ton (Calc) (950 lb/module)
Inner HCal Assy Rings	1650 lb, 1 ton (total) (Calc)
Inner to Outer load transfer rings	6400 lb, 3.5 ton (total) (Calc)
Flux return end caps	226,000 lb 113 ton (Calc)
Magnet + stack wt	42,000 lb 21 ton (measured+stack estimate)
Total Detector load on Central Pedestal (CP)	1,255,000 lb 628 tons
CP weight without magnet and detectors	250,000 lb 125 tons (rough estimate)

sPHENIX Integration Interfaces

We have identified all significant Interfaces

- **Central Pedestal (CP)**: rails, pistons, HCal mounting , platforms supports, breakers, power distribution, water manifolds, racks, valve box, dewars, flux return caps, safety systems, permanent access
- **Outer HCal**: CP, Magnet, Inner HCal mounting rings and alignment, rack power, data, monitoring and control services connections
- **Inner HCal**: Outer HCal, EMCal, rack power, data, monitoring and control services connections
- **EMCal**: Inner HCal, rack power, data, monitoring and control services connections, cooling services
- **Tracking**: rails, Outer HCal, control rack power, data, monitoring and control services connections
- **SCMagnet**: Outer HCal, SCMagnet, service stack connections, cryo supply, power, monitoring and control services connections.

sPHENIX Assembly and Integration Tooling and Fixtures

We have identified all of our significant tooling needs:

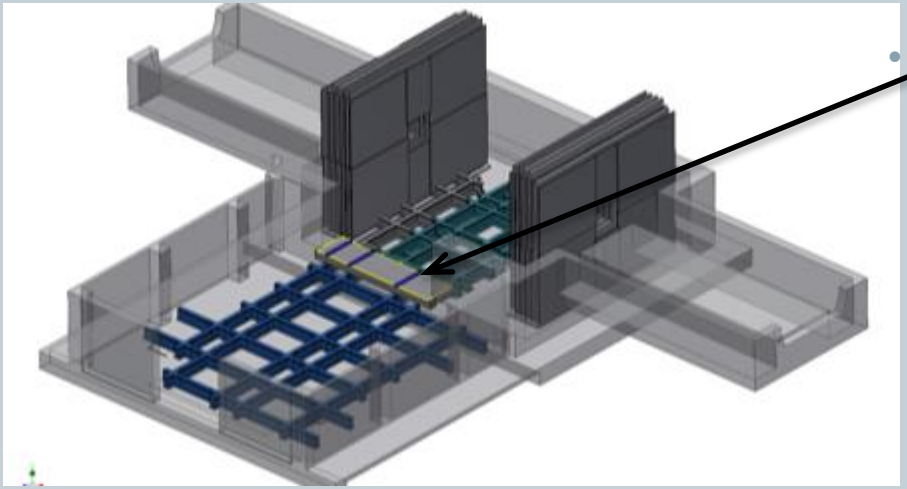
- **Central Pedestal (CP)**: (standard lifting tools for CP base and rollers, cradle, support posts, bridge, access stairs), alignment tools for rollers and cradle.
- **Outer HCal**: module holding fixture (4), indexed lifting/installation fixture, alignment tools, temporary inner & outer support assembly fixtures
- **Inner HCal**: module holding fixture (4), module lifting fixture, assembly indexed/rotating fixture and insertion beam and insertion beam lifting fixture, alignment tools
- **EMCal:** module handling fixture (8), rail alignment tool, indexed lifting/installation fixture
- **Tracking**: Handling fixture (2), alignment tool, installation tool
- **SC Magnet**: Lifting fixture (spreader bar), alignment tool, stack handling/lifting tool
- **Infrastructure**: beampipe alignment tools/fixtures, bakeout tools/fixtures

Prior to Assembly

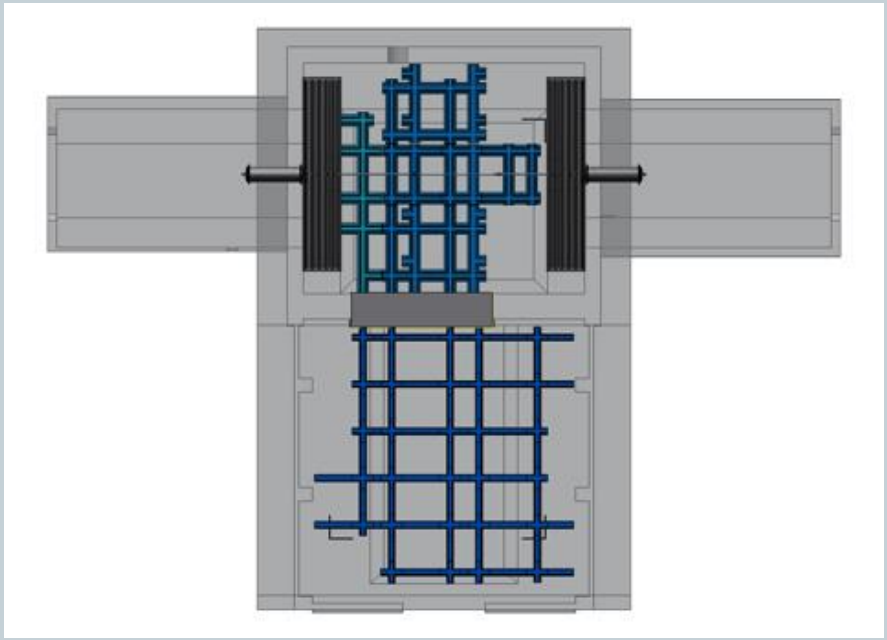
- Pre-requisites ready to begin assembly
  - Decommissioning complete
  - temporary beampipe in place
  - shield wall base in place
  - Assembly Hall prepped for sPHENIX Installation
  - Assembly and Infrastructure design and safety reviews and approvals complete
  - Assembly and Infrastructure work planning, permits on schedule to be completed and approved as required
  - Subsystem modules on schedule to be ready for installation as required

Ready to Begin

- Infrastructure at 1008 AH and IR modified as appropriate. Beampipe installed in IR with temporary supports and baked out for run)

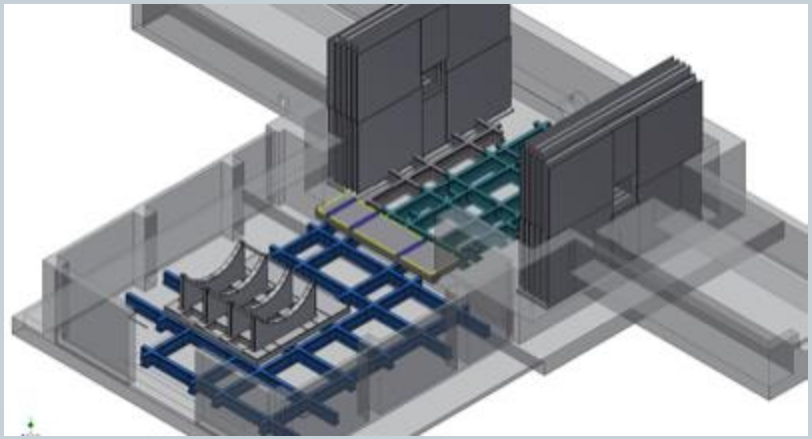


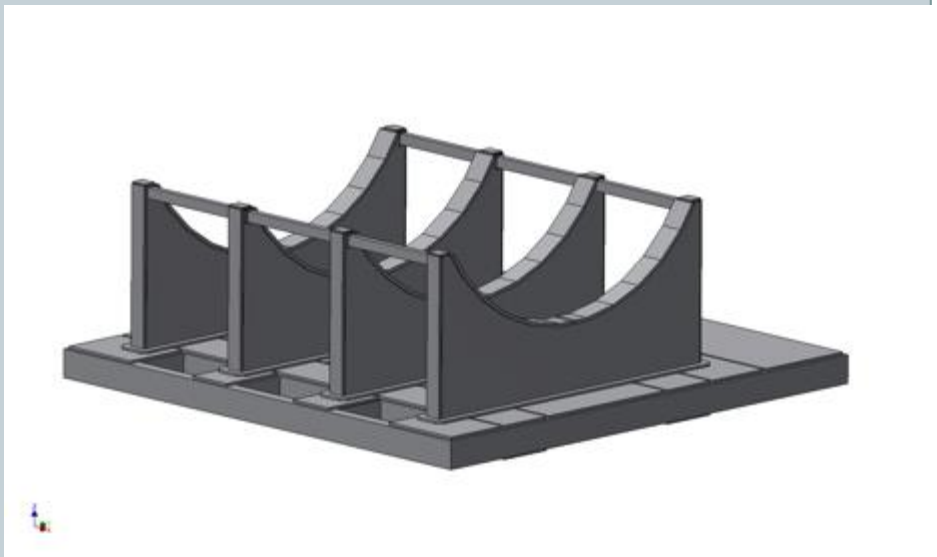
- Shield wall base in place



Central Pedestal (CP) Base

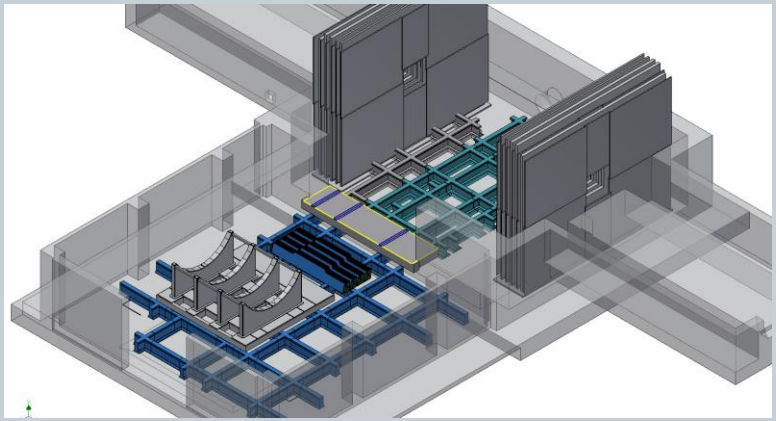
- Gather and stage CP Base components (base platform sections, Hillman Rollers, X-Y alignment details, cradle arcs)
- Assemble lower platform
- Install and position cradle arcs and cross members
- Survey cradle arcs, adjust alignment and indexing, weld in place
- Position, align and install Hillman Rollers

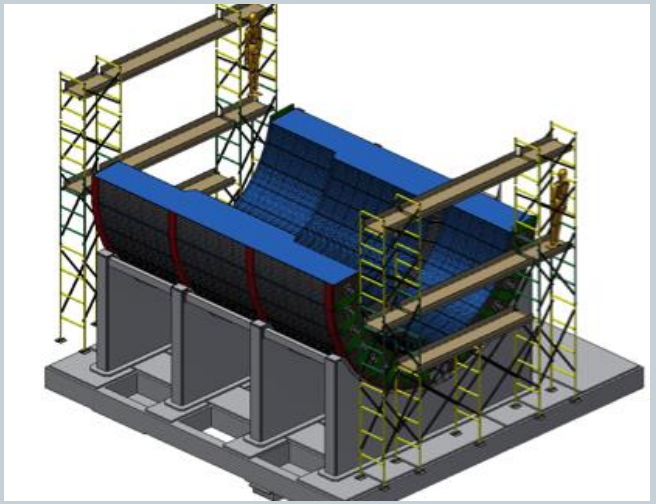


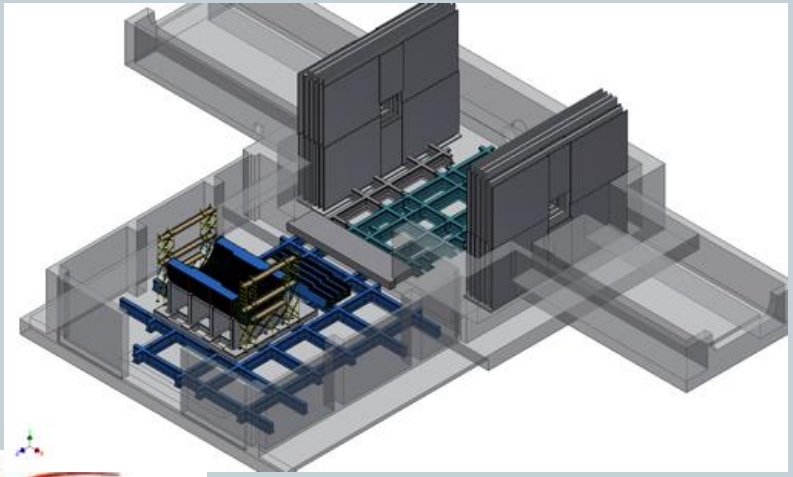


HCal Lower Half

- Transport & Install the Outer Hcal lower half

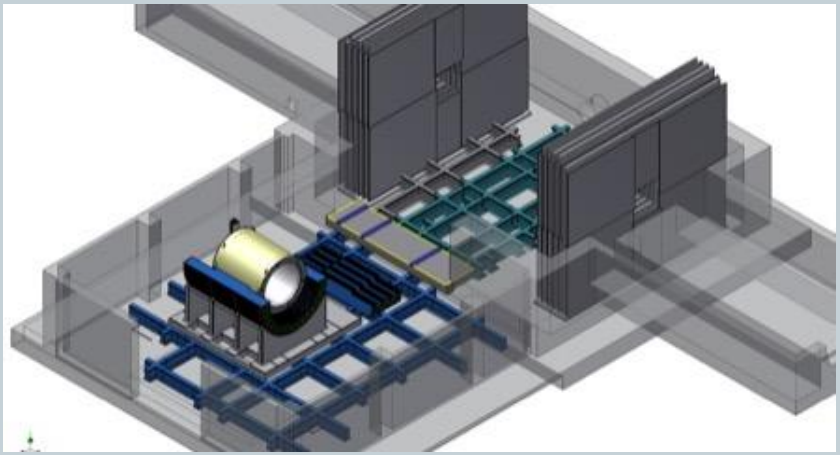


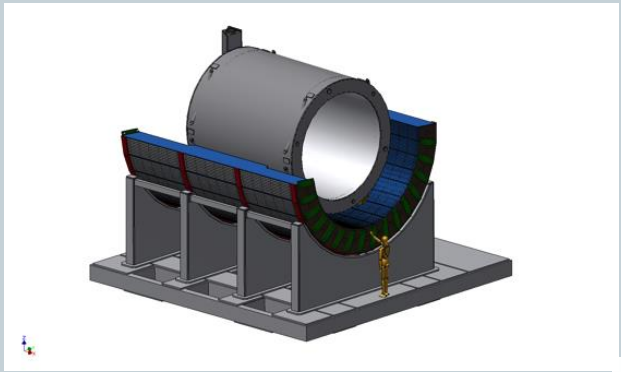




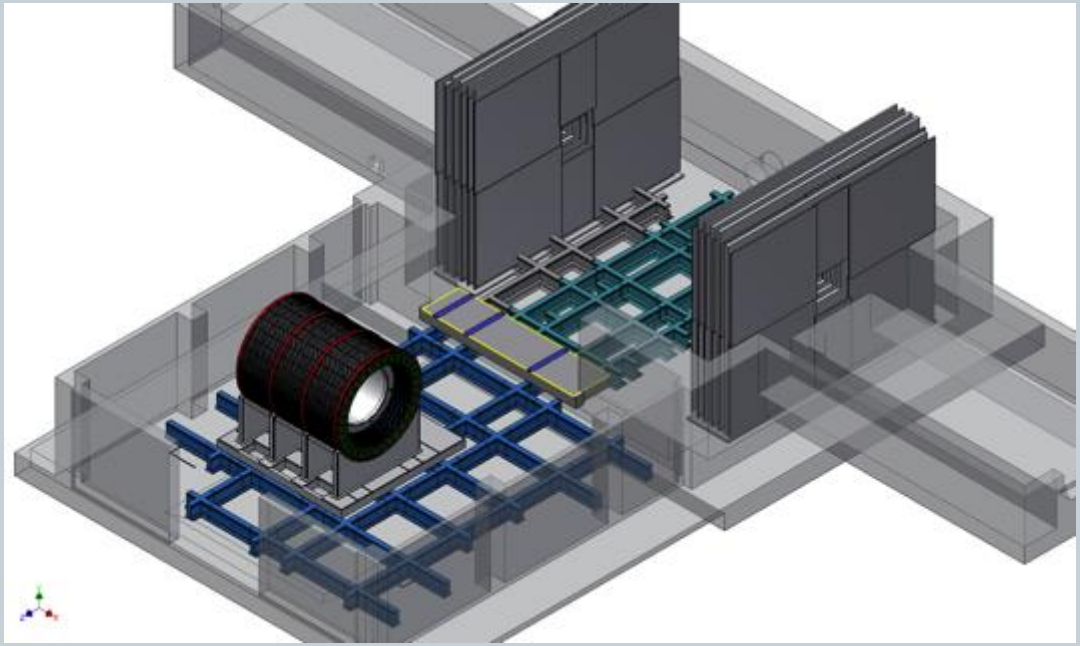
Magnet

- Transport the Magnet to the AH
- Mount on the Outer HCal
- Survey into position

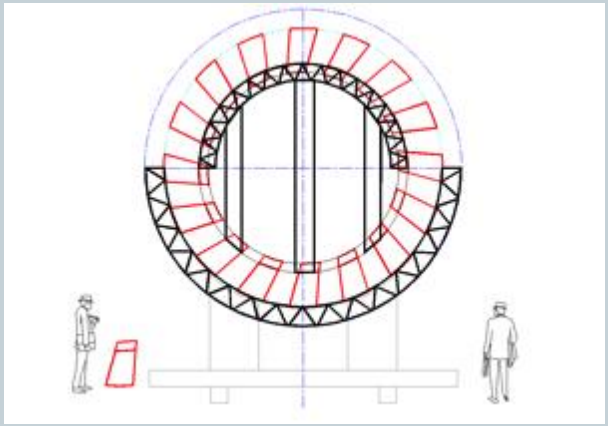




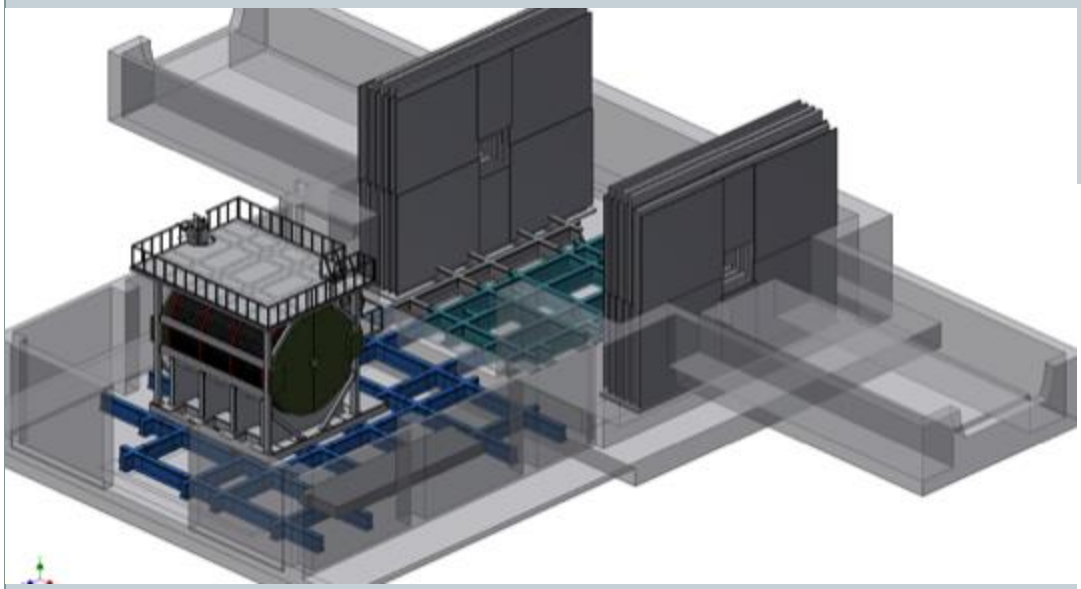
Top Half of Outer HCal



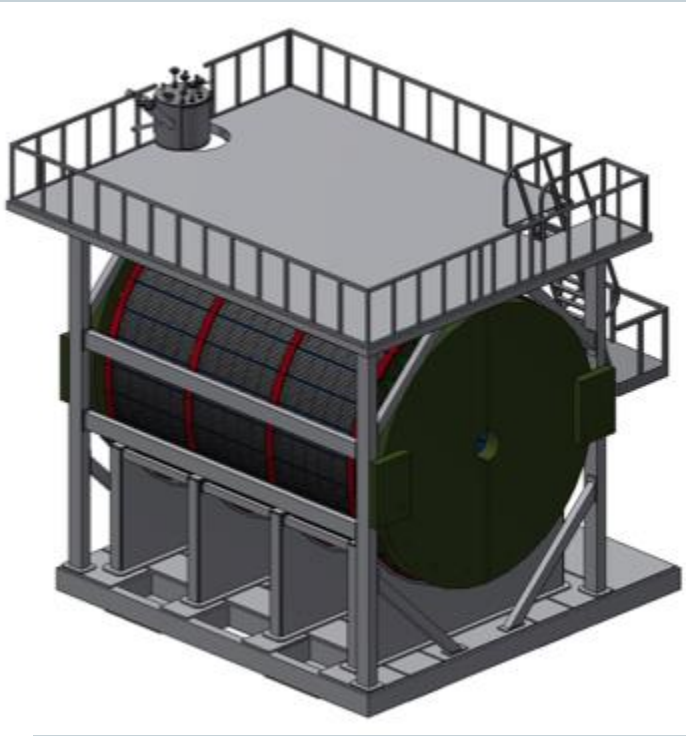
- Install custom temporary Upper HCal support/alignment fixture
- Increase scaffolding for upper half of Outer HCal installation.
- Repeat module installation steps until all 32 modules are installed
- Test individual module electronics to assure that electronics have not been damaged during assembly



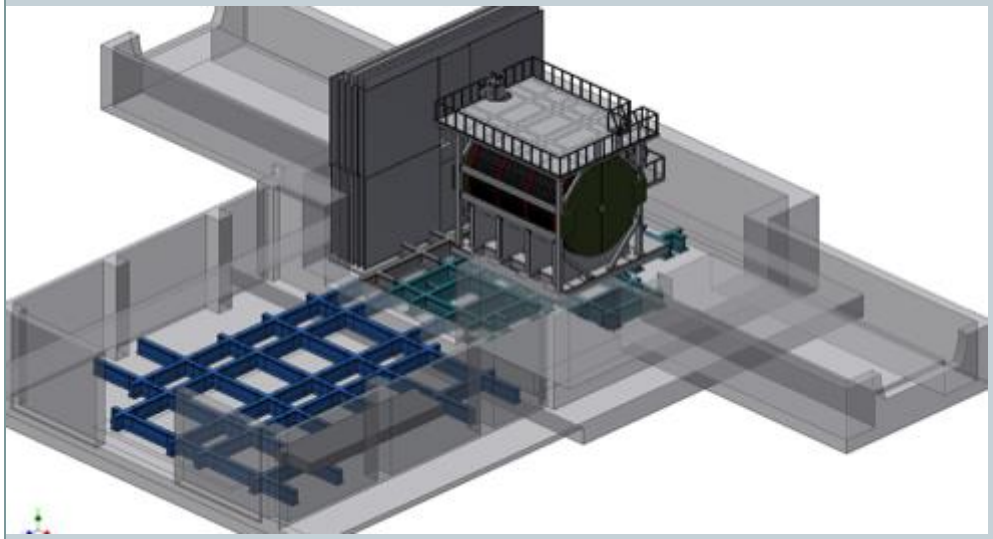
Platform & Magnet Stack



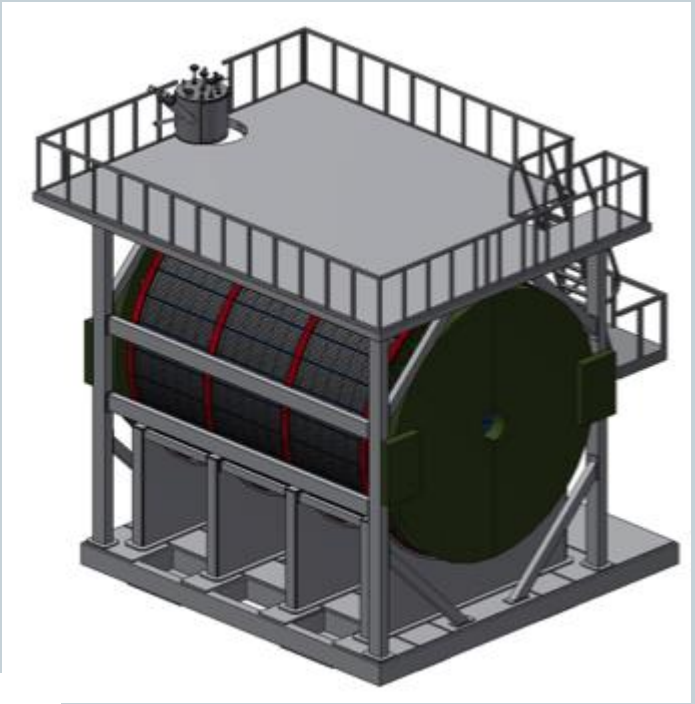
- Install upper platform support columns and bracing
- Install SC magnet Stack
- Install Flux return End Caps



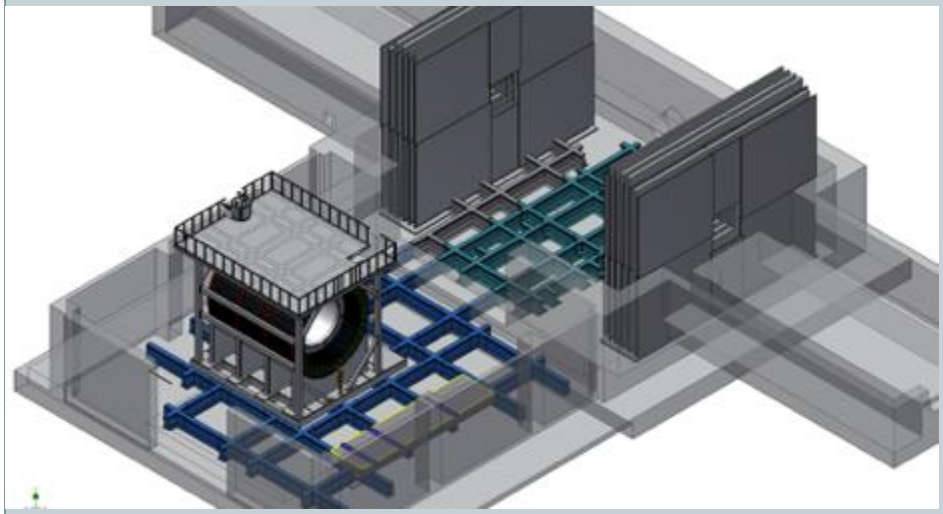
Magnet Mapping



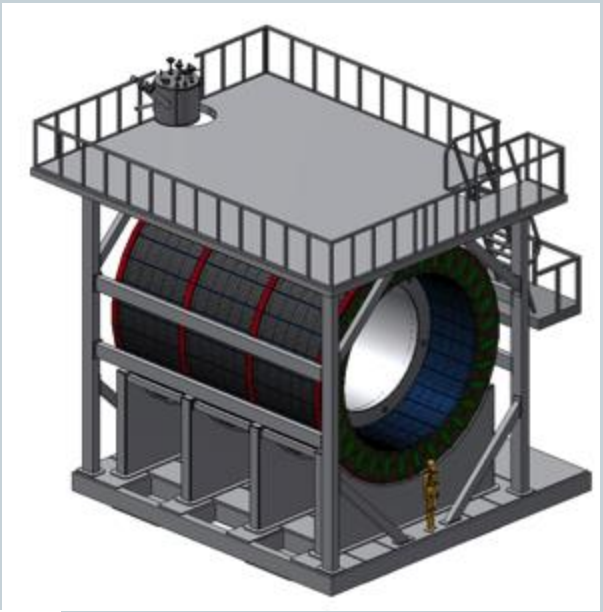
- Move CP carriage to IR for testing
- Connect SC magnet cryo and electrical power for full field test and magnet mapping
- Magnet tests and mapping



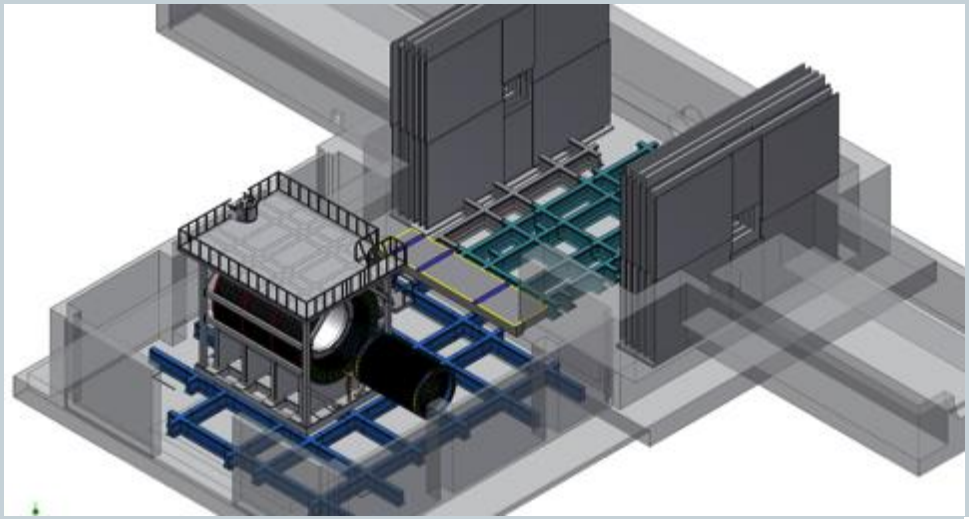
Outer HCal Cabling and Services



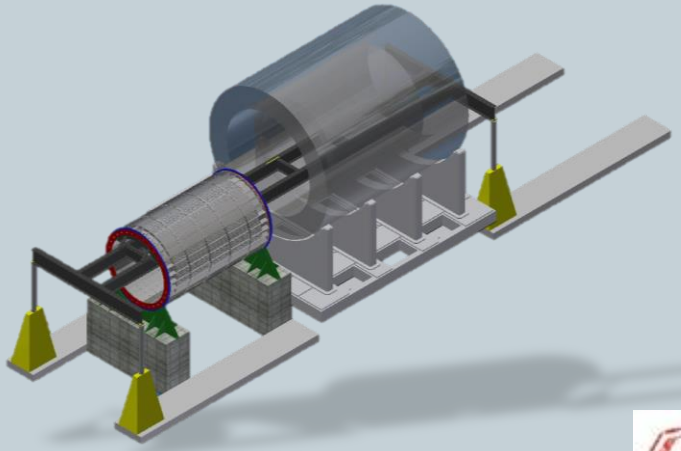
- Move CP back to AH for additional assembly
- Remove End Caps
- Install patch panels, cable management hardware, cable trays for Outer HCal .
- Route Outer HCal cables and fibers to Outer HCal racks
- Test all connections

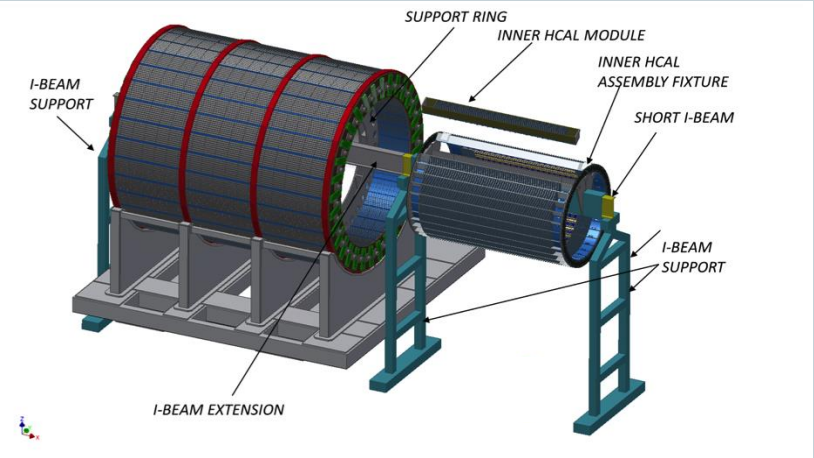


Inner HCal



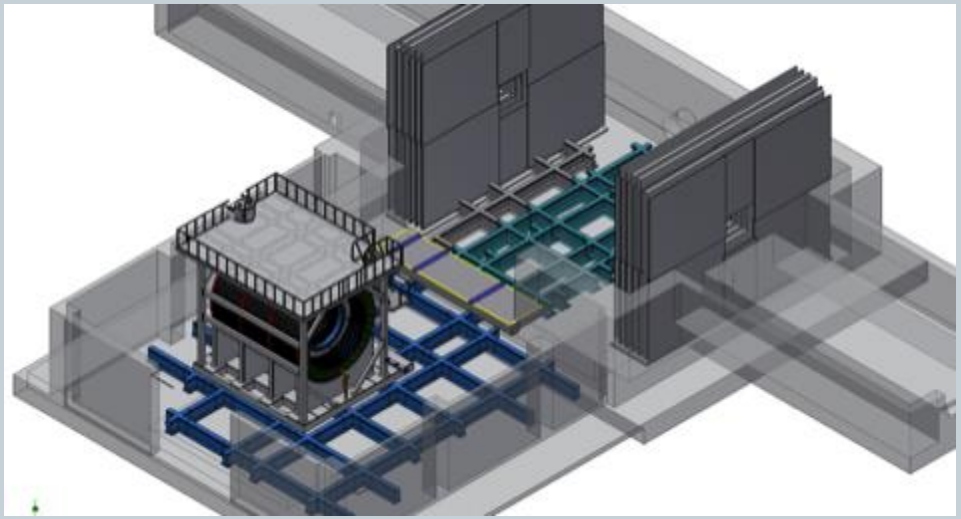
- Transport Inner HCal completed modules to AH
- Test to make sure electronics are intact after transport
- Assemble Inner HCal in rotating assembly fixture 1 module at a time
- Final adjustments and lock
- Install Inner HCal mounting supports
- Install beam extension
- Install the full Inner Hcal, align and attach to the Inner HCal mounting supports.
- Install patch panels, cables, and route to racks
- Test all connections

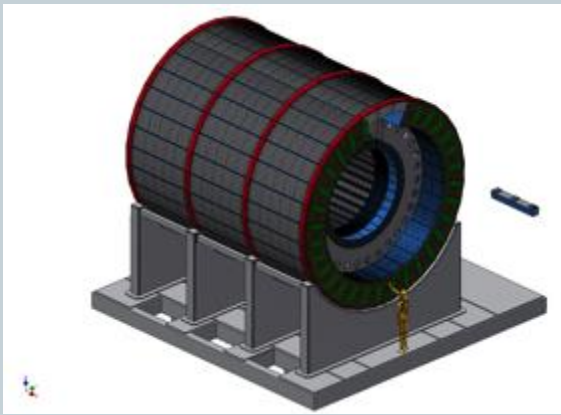


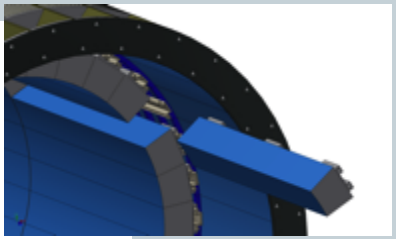


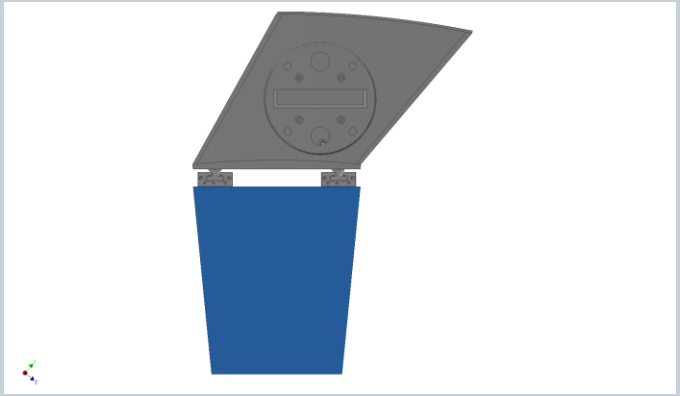
EMCal

- Transport modules to AH
- Test to make sure electronics are intact after transport.
- One by one Insert and align the 32 south EMCal modules using the indexed insertion tool.
- Repeat for north side
- Make final alignment adjustments and secure and lock all modules in place.
- Install patch panels, cables, services and route to racks
- Test all connections

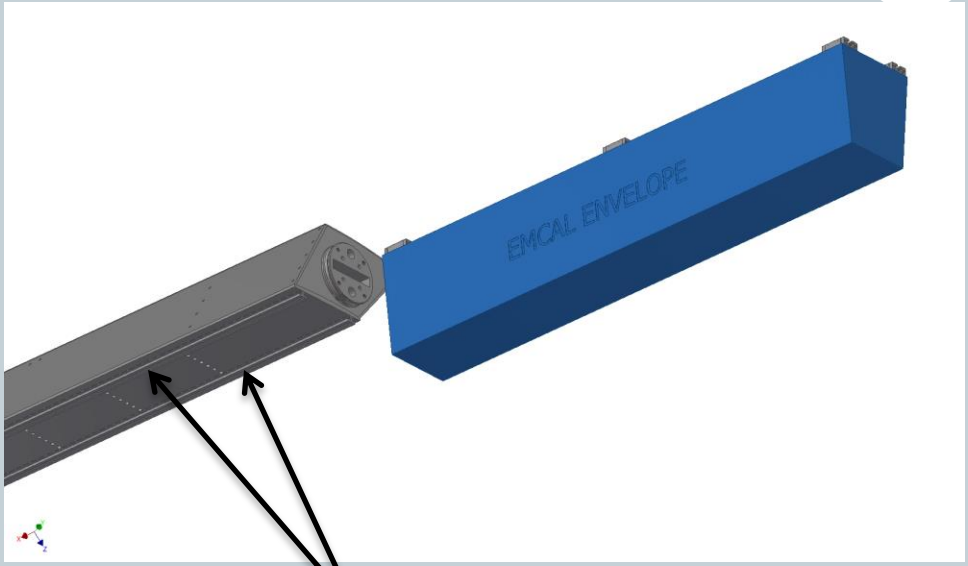




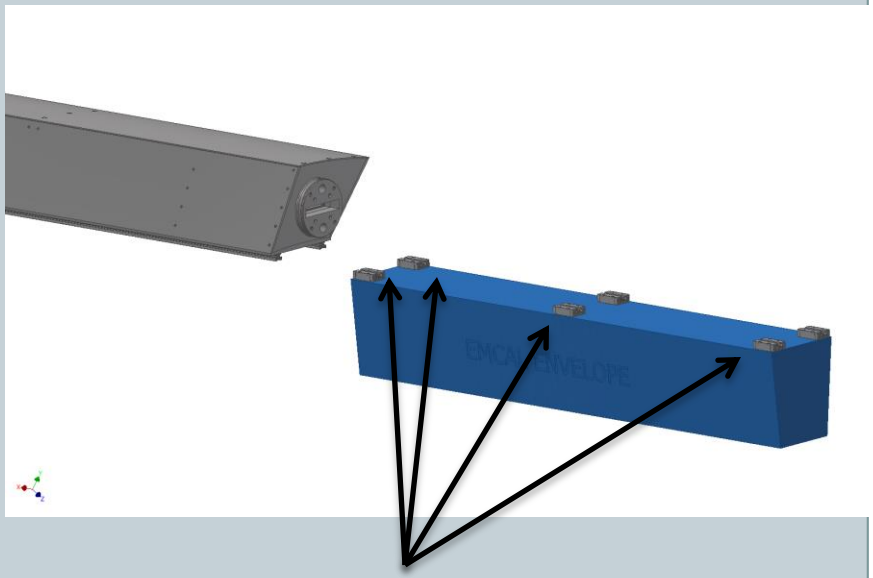




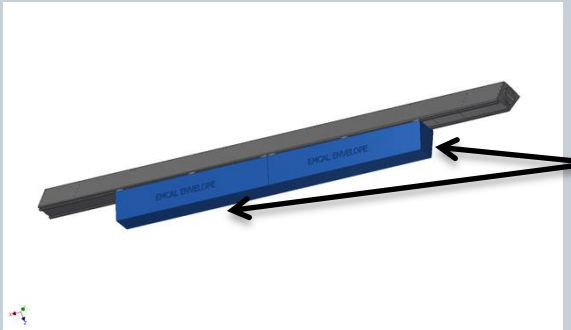
EMCal Installation



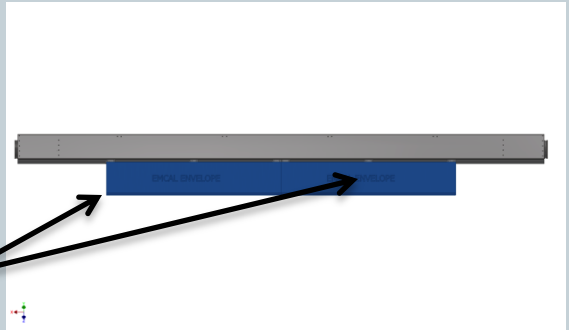
Rails attached to Inner HCal Sectors



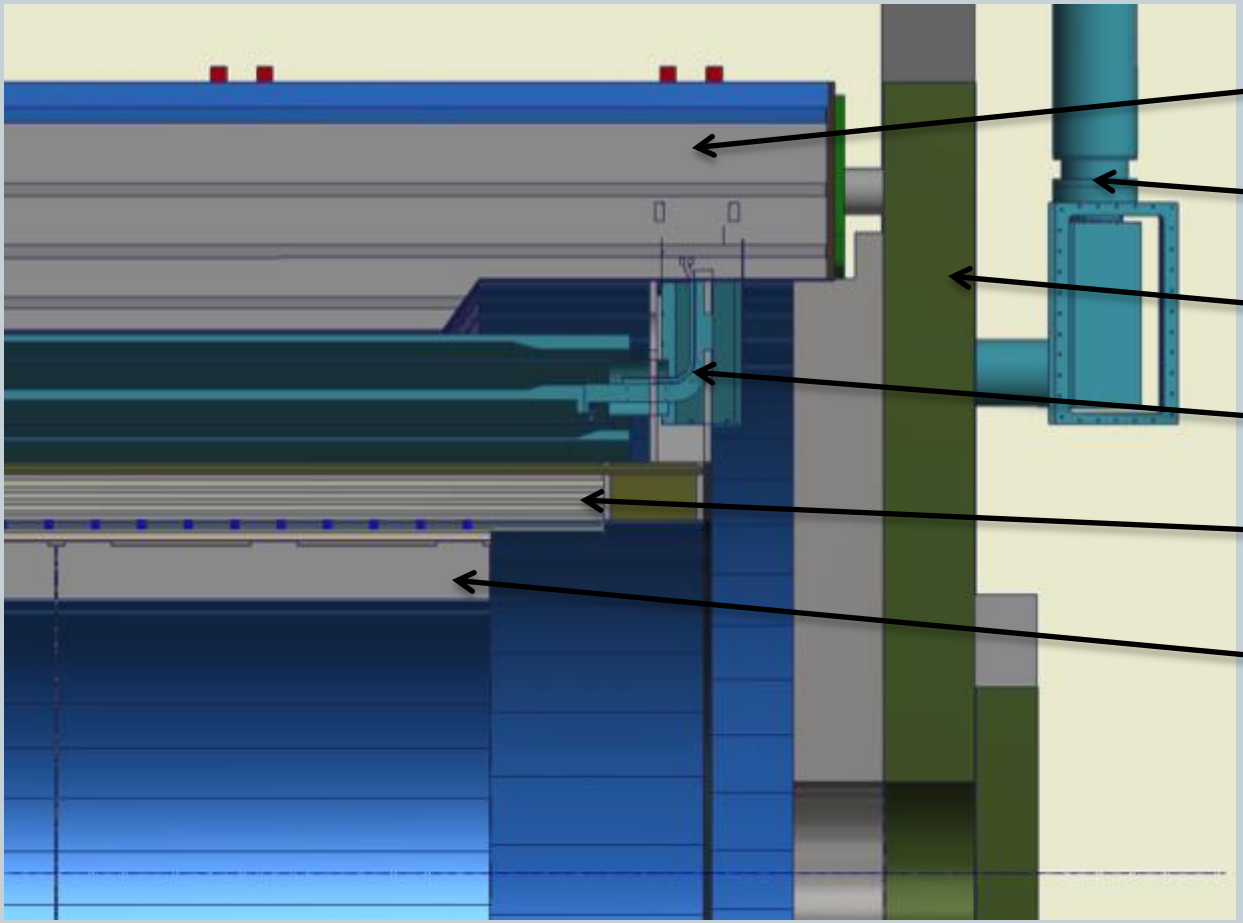
Bearing blocks attached to EMCal sectors



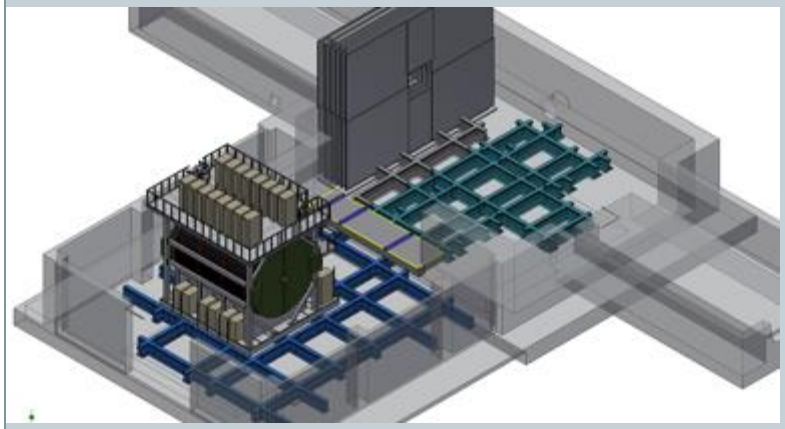
2 EMCal sectors (north and south) attached to each Inner HCal Sector



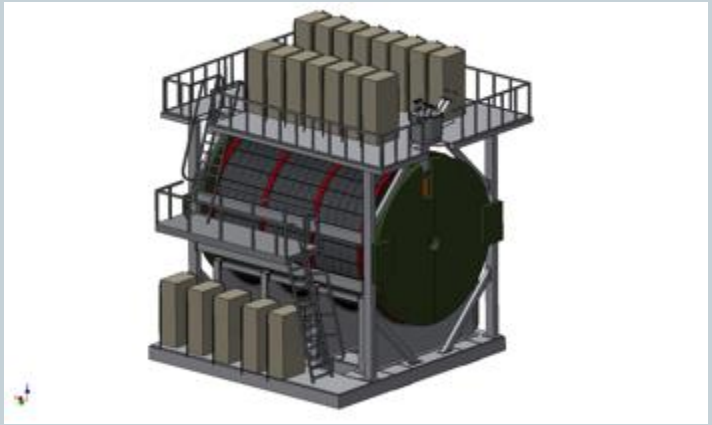
Detector Cross Section



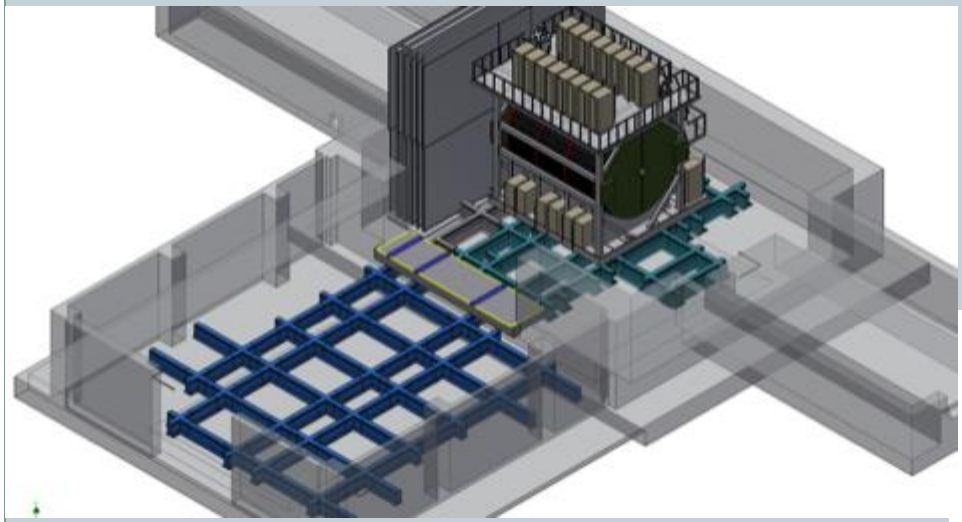
Tracker & Flux Return End Caps



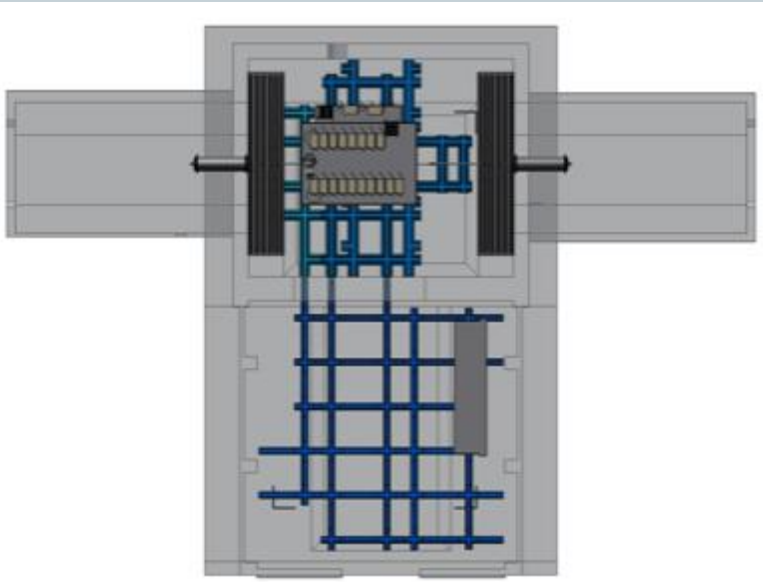
- Install the Tracker
- Remove scaffolding
- Re-install the end plugs



Complete Assembly and Commissioning



- Move CP back to IR
- Commission all Detectors
- Install BP, align and bakeout
- Install Magnet Cryo & power
- Final full field test
- Ready for first run



sPHENIX in the IR